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PREVENTION OF WASTE AND SEASONAL PRICE FLUCTUATIONS THROUGH REFRIGERATION

By George K. Holmes,

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Cold storage was originally and primarily used for the purpose of preventing the waste of foods. The Indians of the northern part of what is now the United States, and of Canada, packed fresh meat in snow to avoid thawing. They were found doing this when the white race first came and the whites adopted the practice. In the course of time the whites had their ice houses, which provided cold storage facilities for milk and butter, fresh meat, berries and other foods for very short periods of time. The main object was to prevent waste. The extension of ice cooling to refrigeration in commercial use followed and also the packing of dressed poultry, fresh oysters and other perishable foods in ice for shipment.

As foods were placed in some sort of temporary cold storage to prevent waste, it was incidentally observed that their utility was extended in time. The importance of this to men engaged in handling food commercially was very great. With regard to the early commercialization of cold storage, the testimony of Mr. F. G. Urner of the Urner-Barry Company, publishers of the *New York Produce Review* and of the New York *Producers' Price Current*, is quoted:

> The development of the cold-storage industry as a public utility in food preservation was gradual, and it is impossible to specify any year when it began to raise the price of the commodities stored during the season of greatest production, especially as the price levels during that season have been variable, ever since storage has been an important factor.
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> The greatest development of cold storage as a public utility began with the introduction of mechanical refrigeration shortly before 1890. From the latter date the development was rapid. I should say that the system was established as having an influence upon prices during the flush season somewhere from 1890 to 1893, but it would be a work of considerable magnitude to dig out statistics of values which would indicate a positive influence upon prices due to this cause; and, even if the price levels were found to have advanced during the flush seasons in one of those years, it would not be certain that it was due to cold storage, because there are other influences affecting prices that may be of equal importance, and, in considering these influences, it is very difficult, after a lapse of twenty years, to determine the controlling factors.

While I can not answer your questions specifically, my opinion would be that this influence was first felt some time between 1890 and 1893 in respect to fresh meats, dressed poultry, butter, and eggs.

So great has been the development of cold storage that it is now all but impossible to make up a complete list of commodities placed in such storage. These commodities are not only foods, but they include articles that may be destroyed by insects in the larval stage, and non-food articles that may be spoiled by bacteria. The purpose of this storage for some articles is exclusively to prevent waste; with regard to other articles the object is to prolong their commercial utility into seasons when their production is relatively low or has ceased. Notwithstanding the difficulties of compiling a large list, the attempt has been made with the result found in the list on pages 55–56.

Commercial cold storage has become so diversified and has so thoroughly entered into many lines of business that the number of public and private warehouses that provide facilities for such storage has grown to nearly 1,000 in the United States. In the absence of necessary information it is impossible to estimate the value of the commodities placed in these warehouses during one year, but the factors for making an estimate for fresh beef, mutton and pork, and butter and eggs have been roughly determined by the writer and these factors indicate that the value of fresh beef placed in cold storage in a recent year (mean of 1909–1910 and 1910–1911) was about $15,000,000; of the fresh mutton, $1,600,000; of the fresh pork, $18,000,000; of the butter, $40,000,000; and of eggs, $64,000-000. The total wholesale value of these five commodities received into cold storage during the year was about $138,000,000 at the mean wholesale prices of the year in many cities throughout the United States. The quantity of these commodities received into cold storage during that year has been computed to be as follows: Fresh beef, 131,000,000 pounds; fresh mutton, 20,000,000 pounds; fresh pork, 176,000,000 pounds; butter, 157,000,000 pounds; eggs, 296,000,000 dozens. If these quantities are compared with the production of the census year 1909, these fractions follow: Of the fresh beef, census slaughter, 3.1 per cent; of the fresh mutton, census slaughter, 4.1 per cent; of the fresh pork, census slaughter, 11.5 per cent; of the butter, census farm and factory make, 9.6 per cent; of the eggs, census farm production, 18.7 per cent; of the eggs, cen-

sus farm production plus one-fourth for conjectured non-farm production, 15 per cent.

Much definite information has been obtained by the writer for the National Department of Agriculture with regard to the business of the keeping in cold storage of fresh meats, dressed poultry, butter and eggs. This was obtained from cold storage warehouses in all parts of the United States and was stated by them in such form as to permit calculations that establish a great variety of results. These commodities have seasons of relatively high and relatively low production, a condition that makes them especially suited to cold storage for the purpose of taking them out of a period of natural high production and carrying them forward to the period of natural low production. According to the reports made by warehousemen, the principal months when fresh beef is placed in cold storage are September, October and November; mutton, August, September and October; butter, June, July and August, and sometimes May; eggs, April, May and June. Pork is quite well distributed throughout the year, and the prominence of winter receipts in cold storage is barely perceptible. Poultry is made up of diverse elements. Broilers go into storage from the latter part of August until November and roasters from October to December. There are, besides, the different varieties of poultry, including turkeys. November, December and January, and sometimes October, and even August and September are the heavier cold-storage months.

During the three heavier cold-storage months of 1910–1911, 47 per cent of the fresh beef placed in cold storage during the whole year was received into the warehouses, 59.8 per cent of the fresh mutton, 59.2 per cent of the dressed poultry (November, December and January); 70 per cent of the butter, and 79.4 per cent of the eggs. On the other hand, in the lighter cold-storage months of the same year, February, March and April, 10.3 per cent of the fresh beef placed in cold storage during the whole year was received into the warehouses; in May, March and April, 8.1 per cent of the fresh mutton; in May, June and July, 3.4 per cent of the dressed poultry; in February, March and April, 2.7 per cent of the butter, and in December, January and February, 1.4 per cent of the eggs.

The variations of seasonal production are little known by the general public. They are not so large as is often supposed for pork, butter and eggs. The Cincinnati *Price Current* collects statistics

of hog slaughter "in the West," and, based on these statistics, the mean monthly percentages of the annual slaughter for the nine years 1903–1911, are as follows, beginning with January: 10.7, 9, 7.5, 7.2, 8.7, 9.3, 7.7, 6.7, 6.1, 7.3, 9.2, 10.6; total 100. From the records of 197 creameries properly distributed geographically, obtained from the Dairy Division of the Bureau of Animal Industry of the U. S. Department of Agriculture, the following percentages of the year's production of butter in 1910 have been computed, beginning with January: 6.4, 5.5, 6.8, 7.9, 11, 12.5, 10.6, 9.6, 9.2, 7.9, 6.5, 6.1; total, 100. For the purpose of this study, all of the normal egg-laying records that could be found have been consolidated, and the production of each month has been converted into a percentage of the annual total. The percentages, beginning with January, follow: 6.6, 7.1, 12.4, 13.4, 13.3, 10.7, 9.6, 8.6, 6.2, 4.2, 3.1, 4.8; total, 100.

The length of time during which fresh beef, mutton and pork and dressed poultry, butter and eggs are usually carried in cold storage is a few months. This fact is established by the reports of many warehouses which contributed the information summarized in this article. Newspapers have led the public to believe that these foods are commonly stored during fabulous periods, but the facts are as herein stated. It is established that 71.2 per cent of the fresh beef received into cold storage in the year 1909–1910 was delivered within three months, 28.8 per cent of the fresh mutton, 95.2 per cent of the fresh pork, 75.7 per cent of the dressed poultry, 40.2 per cent of the butter, and 14.3 per cent of the eggs. Within four months after it was received, 86 per cent of the fresh beef was delivered, 42.7 per cent of the fresh mutton, 96.5 per cent of the fresh pork, 85.3 per cent of the dressed poultry, 53.4 per cent of the butter, and 22.6 per cent of the eggs. The percentage of receipts delivered in seven months is 99 for fresh beef, 99.3 per cent for fresh mutton, 99.9 per cent for fresh pork, 96.1 per cent for dressed poultry, 88.4 per cent for butter, and 75.8 per cent for eggs. Lastly, let the percentages for the deliveries of ten months be stated. These are represented by 99.7 per cent for fresh beef, 99.5 per cent for fresh mutton, 99.9 per cent for fresh pork, 98.9 per cent for dressed poultry, 97.8 per cent for butter, and 99.9 per cent for eggs.

There is always a carry-over of these commodities into the next natural storage year, due almost entirely to the reception into cold

storage near the end of the year. While the principal portion of the receipts into cold storage during the year are found in certain months of relatively large production, yet there are receipts during every month of the year and a large portion of those near the end of the storage year are carried into the next year. From the natural storage year ending August, 1910, 9.6 per cent of the receipts was carried over to the next year in the case of fresh beef; the percentage for fresh mutton for the natural storage year ending July, 1910, was 15.1 per cent; for fresh pork for the natural storage year ending April, 1910, 5.4 per cent; for dressed poultry for the natural storage year ending July, 1910, 7.7 per cent; for butter for the natural storage year ending April, 1910, 4.9 per cent, and for eggs for the natural storage year ending February, 1910, 0.2 of 1 per cent.

In the investigation of cold storage by the writer for the U. S. Department of Agriculture, some of the results of which are utilized in this article, the warehousemen reported the receipts and deliveries for each month of certain years, and consequently it is easy to compute the average time of storage. The fresh beef received into storage during the year beginning May, 1909, was kept there on the average for 2.28 months; the fresh mutton, 4.45 months; the fresh pork, 0.88 of 1 month, and the butter 4.43 months. The dressed poultry received during the year beginning March, 1909, was kept on the average 2.42 months; the eggs, 5.91 months.

If a portion of a product is withheld from consumption at a time of the year when production is relatively large and released for consumption at a time of the year when production is relatively small, the academic logic of the proceeding is that prices will be raised during the period of natural surplus and depressed during the period of natural scarcity, so that there will be in operation an equalizing force. Prices should be more even through the year than they were at a time when there was a glut in one season and a scarcity in another.

To test this logic with facts it is necessary to establish the mean wholesale prices of the six commodities under discussion, and such prices have been obtained for many cities of the United States and properly consolidated to form a single mean for each month from 1880 to 1911. This whole period is divided at 1893 and the price statistics of the preceding years have been consolidated to a

single mean for each month for each commodity. This period is distinctly an antecold-storage period.

The cold-storage period beginning in 1893 and ending with 1911 is subdivided into two periods at 1902 for the purpose of making a group of the more recent cold-storage years during which the business reached its highest development. These three periods are referred to conveniently as the first, second and third.

The mean prices established as already mentioned have been converted into index numbers by the process of using the mean monthly price of the year as a divisor and the price of each month as a dividend. Index numbers so computed stand for relative wholesale monthly prices and avoid expression in dollars and cents. A treatment of the problem by using prices expressed in money instead of in index numbers would thoroughly befog the matter for the reason that the purchasing power of money and also cost of production and the relationship between demand and supply have changed. It is only necessary to compare the mean relative prices of the index numbers for the first period with those for the third period to determine whether there has or has not been a tendency toward equalization of prices. It is evident that, if the prices for all of the months were the same, the index numbers would all be 100. Every departure from uniformity of prices in cents is a corresponding departure from uniformity of index numbers.

Let the first and third periods be compared for prices of fresh butter in New York, as compiled by the Urner-Barry Company. For 11 of the 12 months there was a tendency toward uniformity and for one month, April, a tendency away from uniformity of prices.

If the prices index numbers of the first period, which stand for fresh butter, are compared with those for cold-storage butter in the third period, it is evident that for every one of the 12 months there was a tendency toward uniformity of prices.

The evidence for eggs is similar, but not so strong. A comparison of the first and third periods for fresh eggs finds a tendency toward uniformity of prices in 8 months and away from uniformity in 4 months; and if the fresh eggs of the first period be compared with cold-storage eggs of the third period, there is a tendency toward uniformity of prices in 10 months and away from uniformity in 2 months.

Comparison may be made also for the consolidated prices compiled for many cities. Comparison is made between the first and third periods, and no cold-storage prices are included. There are 13 monthly quotations for each year, for the first of each month; January 1, following the calendar year, being included to round out the year.

For beef there was a tendency toward uniformity of prices for only 3 of the 13 months; for mutton, for 9 of the 13 months; for pork, for only 3 of the 13 months; for dressed poultry, for 8 of the 13 months; for butter, for 11 of the 13 months; and for eggs, for 9 of the 13 months. The general fact may be regarded as established that there was a tendency toward uniformity of prices for four of the commodities, and that there was a contrary tendency for fresh beef and fresh pork. The abnormal circumstances affecting the slaughter of cattle and hogs in the third period very likely account for the apparent exceptions of fresh beef and fresh pork to the general fact of tendency toward uniformity of prices. At any rate there is no evidence that the tendency away from uniformity of prices for fresh beef and fresh pork was due to anything done by the great packing-houses.

It is only by comparing the mean of a period of years with the mean of another period that the broad principle with regard to this matter can be established. If two adjacent years are compared, the results will differ more or less from those for the averages of periods of years, as appears in the following comparison: The period from October, 1909, to October, 1910, was a fairly normal one in the matter of production, supply, and price of butter and eggs, but more or less abnormal with regard to fresh meats. The year from October, 1910, to October, 1911, was abnormal for butter and eggs, as well as for the other commodities. There was a marked tendency toward inequality of prices from the former to the latter year in the case of beef, pork, butter and eggs, and a tendency equally marked toward uniformity of prices in the case of mutton, while in the case of poultry, there was a perceptible, but not pronounced, tendency toward uniformity of prices.

It is therefore apparent that the contention of the cold-storage interests that cold storage has counted for uniformity of prices is largely true, but it is not true for all commodities nor for all comparisons of years and periods.

The problem is a complicated one and the factors are not all ascertainable, or certainly not with definiteness. That there should be, *a priori*, a tendency toward equalization of prices under the régime of cold storage in comparison with the antecold-storage period has seemed a logical conclusion to many intelligent men and has been the contention of the cold-storage interests. May it not be that the logic of the matter is disturbed by its human element, by the psychology of trade? The customer of the cold-storage warehouse who buys butter in June and places it in cold storage to be sold at some future time must receive a higher price per pound than he paid for it to cover costs and return him a profit. The expectation that he will do so is solely the reason why he is engaged in the business. It depends upon his judgment, whenever any future time has become present time, whether he will receive his highest rate of profit by selling now or by deferring sale until another future time. But all men who have bought butter and placed it in cold storage for future sale may or may not have the same judgment, and herein may be found room for regularity or irregularity of prices, or a tendency toward or away from uniformity, one year compared with another, and one period of years compared with another.

COMMODITIES PLACED IN COLD STORAGE

Ale	Bluing	Citrons	Figs
Ale (ginger)	Brussels sprouts	Clam broth and juice	Fish, canned
Anchovies	Buckwheat	Clams	Fish, dried
Apples, evaporated	Bulbs	Cocoanuts	Fish, for bait
Apples, fresh	Butter	Confectionery	Fish, fresh
Apple waste	Cabbages	Crabs	Fish, pickled
Apricots	Canned foods	Cranberries	Fish, smoked
Aqua ammonia	Cantaloupes	Cream	Flour
Asparagus	Carrots	Cucumbers	Flowers
Bananas	Catchup	Currants	Fruit juices
Beans	Cauliflower	Cymblings	Fruits, California
Beans, string	Caviar	Dates	Fruits, candied
Beef extract	Celery	Eggplant	Fruits, dried
Beef, fresh	Cereals	Eggs	Fruits, fresh
Beer	Cheese	Endive	Furs
Beets	Cherries	Extracts, flavoring	Game (meat and birds)
Berries	Chestnuts	Ferns	Grape fruit
	Cider		

Grapes
Gutta-percha
Herbs
Holly
Honey
Hops
Horseradish
Ink
Jellies
Kale
Lamb, fresh
Lard
Laurel leaves
Leeks
Lemons
Lettuce
Limes
Lobsters
Macaroni
Mandarins
Meats, dried
Meats, fresh
Meats, pickled
Meats, smoked
Medicines, drugs, etc.
Melons
Milk
Milk, condensed
Mucilage
Mushrooms
Mustard, French
Mutton, fresh
Nuts
Oil, olive
Oils
Okra
Oleomargarine
Olives
Onions
Oranges
Oysters
Parsley
Parsnips
Paste
Peaches, canned
Peaches, evaporated
Peaches, fresh
Peanuts
Pears
Pease
Peppers
Pickles
Pineapples
Plants
Plums
Pork, corned hams
Pork, cured hams
Pork, fresh
Potatoes, Irish
Potatoes, sweet
Poultry, dressed
Preserves
Provisions
Prunes
Radishes
Raisins
Rhubarb
Rice
Rose bushes
Salad dressing
Sauerkraut
Sausage casings
Scallops
Shallots
Shrimp
Shrubs
Sirup, maple
Sirups
Skins
Smilax leaves
Spinach
Sponges
Squashes
Strawberries
Sugar, maple
Sweetbreads
Tangerines
Thyme
Tomatoes, canned
Tomatoes, fresh
Trees
Turnips
Veal
Vinegar
Watermelons
Waters, mineral
Wines
Woolens
Yarn
Yeast